AQUATIC VEGETATION

Intermountain & Montane West Freshwater Aquatic Vegetation

Concept: Rooted or floating aquatic plants confined to lakes, ponds, and slow-moving portions of rivers and streams. These aquatic beds are found throughout eastern Washington, from the lowlands to the subalpine, in water too deep for emergent vegetation

Conservation Status: This wetland type has not yet been ranked. These communities remain widespread on the landscape; however, most low elevation occurrences have been impacted.

Distribution: Found throughout eastern Washington across large elevation ranges, from below 1000 feet in the Columbia Basin to over 7000 feet near the Cascade Crest.

Spatial Pattern: Very small patches (100 to >300 m^2) in peatland pools or in slow moving streams and small patches (1 to >25 acres) in ponds and lakes.

Ecological Setting: These wetlands occur in open water areas of ponds, shallow lakes, beaver ponds, peatland pools, along slow-moving streams, and near shorelines of deep lakes. These wetlands are limited to areas with up to 2 m of water that may fluctuate or dry seasonally (Christy, 2004; Kovalchik & Clausnitzer, 2004). Water is too deep for emergent vegetation. In large bodies of water, these wetlands are usually restricted to the littoral region where penetration of light is the limiting factor for growth. Soils can be diverse, ranging from soft anoxic muck to peat to firm sand, but typically present qualities that result from long periods of anaerobic conditions (Kunze, 1994). They are primarily found in mesotrophic to eutrophic ponds, sloughs, lake fringes, oxbows, or very calm water of Rosgen C or E channels. However, these wetlands are occasionally found in oligotrophic waters. Other important ecological factors related to ecosystem development are wave action, water temperature, oxygenation, and water chemistry (Kovalchik & Clausnitzer, 2004). These communities are generally intolerant of wave action (Pierce & Jensen, 2002). Aquatic vegetation is able to tolerate long periods of or permanent anoxic conditions.

Vegetation Structure: Vegetation occurs as two general types of communities: planmergent and submergent communities. Planmergent communities consists of rooted species whose leaves rise to the water surface as well as truly floating plants such as *Lemna* spp. Submergent communities consist of rooted plants that are mostly to entirely submerged for their life-cycle.

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Native Plant Species Composition: Diagnostic species include *Potamogeton* spp., *Polygonum amphibium*, *Nuphar lutea* ssp. *polysepala*, *Azolla* spp., *Callitriche* spp., *Menyanthes trifoliata*, *Ranunculus aquatilis*, *Stuckenia filiformis*, *Lemna* spp., *Ceratophyllum demersum*, *Elodea canadensis*, and *Sparganium* spp. *Menyanthes trifoliata* is the only native decreaser species known to occur in this wetland type but it is not expected in every occurrence. Thus, presence/absence of native increasers is not a useful measure in this type. Native increaser species are difficult to identify as monocultures and low diversity are the norm. Nonnative invasive species include *Myriophyllum spicatum*, *M. aquaticum*, *Nymphaea odorata*, and *Nymphoides peltata*. *Phragmites communis* and *Phalaris arundinacea*, also invasive nonnative species, may establish in these wetlands especially near shorelines.

Hydrology: Water source is variable but predominantly surface flow into natural water bodies such as ponds, lakes, and streams. Groundwater inputs can also occur. For example, areas below lower treeline with permanent water and aquatic vegetation in mid- to late-summer are likely supported by groundwater discharge. Anthropogenic derived flow (e.g., stormwater drainage) could create open water basins where this wetland type may thrive. Relatively flat or gently sloping shorelines support much larger patches than a steeply sloping shoreline. Hydroperiod is permanently to semi-permanently flooded. Some areas (e.g. small depressions) may experience large fluctuations during dry periods to the extent that surface water is no longer present. Various water depths can result in the development of different vegetation zones (floating, submergent, emergent, etc.). These wetlands have high hydrologic connectivity with adjacent wetland types. Rising and falling water levels associated with these aquatic beds have a direct impact on the hydroperiod of adjacent marshes and wet meadows.

Stressors: Hydrological alterations and invasion by nonnative invasive species are primary reasons for degradation. Reservoirs, water diversions, ditches, roads, and human land use in the contributing watershed can have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) result in changes in the amount and pattern of aquatic plant communities. If the alteration is long-term, different wetland community types may establish to reflect new hydrology. Land use in the contributing watershed has the potential to contribute excess nutrients to the system, leading to the establishment of nonnative species and/or dominance of native increasers. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Aquatic communities have decreased along with the diminished influence of beavers on the landscape. On the other hand, in the Columbia Basin, marshes and small ponds have increased in abundance in some areas due to the amount of irrigation water distributed across the landscape. Increased flow to existing wetlands may also lead to corresponding changes in species composition.

Classification Comments:

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Ecological System: North American Arid West Emergent Marsh
HGM: Lacustrine-fringe; Depressional-Freshwater long duration; Riverine-impounded; and Riverine-flow through
Cowardin: L1AB, L2AB, PAB
Other: Kunze (1994) included this type in Low Elevation Minerotrophic, Surge Plain, and Overflow Plain wetlands.
USNVC: Only one other subgroup is associated with the Western North American Temperate Freshwater Aquatic Bed Group (G544). That subgroup, the North Pacific Freshwater Aquatic Vegetation subgroup, is limited to western Washington. The following table shows the U.S. National Vegetation Classification (USNVC) Macrogroup and Group that this wetland type is associated with. USNVC plant associations associated with this subgroup are also listed:

M109 Western North American Freshwater Aquatic Vegetation Macrogroup			
G544 Western North American Temperate Freshwater Aquatic Bed Group			
	Intermountain & Montane West Freshwater Aquatic Vegetation Subgroup	Global/ State Rank	NatureServe/ WANHP Code
Associations	*Azolla* (*filiculoides*, *mexicana*) Herbaceous Vegetation	G4/S4	CEGL003017
	Callitriche (*heterophylla*, *palustris*) Herbaceous Vegetation	G4/S2	CEGL003301
	Ceratophyllum demersum Western Herbaceous Vegetation	G5/S4S5	CEGL004017
	Elodea canadensis Herbaceous Vegetation	G5/S4?	CEGL003303
	Menyanthes trifoliata Herbaceous Vegetation	G5/S4?	CEGL003410
	Nuphar lutea ssp. *polysepala* Herbaceous Vegetation	G5/S4S5	CEGL002001
	Polygonum amphibium Permanently Flooded Herbaceous Vegetation [Placeholder]	G5/S3?	CEGL002002
	Potamogeton (*foliosus*, *gramineus*) - (*Stuckenia filiformis*) Herbaceous Vegetation	GNR/SNR	CWWA000418
	Potamogeton amplifolius Herbaceous Vegetation	GNR/SNR	CWWA000390
	Potamogeton natans Herbaceous Vegetation	G5?/S5	CEGL002925
	Ranunculus aquatilis Herbaceous Vegetation	G5/S4	CEGL003307
	Sparganium angustifolium Herbaceous Vegetation	G4/S3S4	CEGL001990
	Sparganium eurycarpum Herbaceous Vegetation	G4/S2S3	CEGL003323

References:

Christy, J.A. 2004. Native freshwater wetland plant associations of northwestern Oregon. Oregon Natural Heritage Information System, Oregon State Univ.

Kovalchik, B.L. and R.R. Clausnitzer. 2004. Classification and management of aquatic, riparian, and wetland sites on the national forests of eastern Washington: series descriptions. Gen. Tech. Rep. PNW-GTR-593. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Kunze, L.M. 1994. Preliminary classification of native, low elevation, wetland vegetation in western Washington. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA. 120 pp.

Pierce, J.R. and M.E. Jensen. A Classification of Aquatic Plant Communities within the Northern Rocky Mountains. Western North American Naturalist 62(3), pp. 257-265.

Aquatic Vegetation

North Pacific Eelgrass Bed

Concept: Periodically or permanently submerged marine shorelines capable of supporting eelgrass and or other seagrasses. Eelgrass beds are found in Grays Harbor, Willapa Bay, and portions of the Puget Sound. *Zostera marina* (= *pacifica*) is the dominant species.

Conservation Status: Vulnerable (S3). There is some uncertainty about current ecological integrity, severity of threats, and long-term trends. This rank was originally assigned to the North Pacific Maritime Eelgrass Bed Ecological System, which is synonymous with this subgroup (Rocchio & Crawford, 2015b).

Distribution: In Washington, *Z. marina* beds are found in Grays Harbor, Willapa Bay, and portions of the Puget Sound. Regionally, *Z. marina* grows in clear-watered intertidal zones of bays, inlets, and lagoons from southern Oregon (Coos Bay) north into the Gulf of Alaska, Cook Inlet, and Bristol Bay coasts.

Environment: *Z. marina* requires sandy to muddy substrates in a variety of geographic and geomorphic settings. It is most often found along relatively protected shorelines and within shallow embayments where water movement is sufficient to keep concentrations of nutrients in the water column relatively low. At the same time, wave action must be such that there is minimal erosion of substrates and dislodging of shoots and there is moderate sediment nutrient concentrations (DNR 2005). Common substrates include marine silts, but may also include exposed bedrock and cobble, where many algal species become attached with holdfasts. Light must generally exceed 11% of surface radiation to allow for sufficient photosynthetic activity. *Z. marina* can tolerate water temperatures from 0°C to 40.5°C and salinities from 0 – 35 parts per thousand (ppt), but optimum ranges for photosynthetic/respiration rates and seed germination are narrower and vary locally. These physical requirements usually result in distribution of *Z. marina* between approximately 0 and -15 m MLLW (mean lower low water) where water clarity is high (DNR 2005). It is rarely exposed to the air. Maximum depth is generally controlled by light limitations and minimum depth by desiccation, thermal stress, and disturbance (e.g. burial by sediment and ice scour, in addition to erosion from wave action). Exact depth ranges vary depending on local natural and anthropogenic drivers. Other seagrass species may be present at upper depth limits.

Vegetation: Saltwater aquatic herbs in the near-shore shallow environment, dominated by *Zostera marina*. Macrophytic algae may be present. In the Pacific Northwest, *Z. japonica* and occasionally Ruppia maritima may be found. Because *Z. japonica* is not native to this region and may displace *Z. marina* in shallower areas, its presence should be noted. Within its broad range, these communities may be codominated by *Phyllospadix scouleri*, *Fucus distichus*, *Postelsia palmiformis*, and a host of green and brown algae. Adjacent subtidal zones, where rocky substrates are common, support undersea kelp "forest".

Ecological Processes: At broad geographic scales, important determining factors for *Z.marina* distribution include climate (precipitation, insolation, air and water temperatures, currents/upwelling/littoral cells), weather (timing of thermal stress and tides, timing and severity of storms, ice), tidal range (affecting light and flushing), types and magnitudes of freshwater inputs (affecting mean salinity and variance), and marine/freshwater sources of sediments, suspended particulates, and dissolved nutrients (DNR 2005). Latitudinal and regional clines in these factors create related gradients in morphology, genetic diversity, rates of sexual reproduction, and associated epiphytic and benthic biota. At local scales, geomorphic attributes and environmental factors include substrate, aspect, beach slope, fetch, tidal range or prism, sources of sediment, suspended particulates, and dissolved nutrients, as well as frequency of disturbance and mechanical damage caused by freezing, desiccation, ice, burial, and erosion (DNR 2005). Local biological factors such as herbivory, disease, epiphytism, and competition for light (with seaweeds and phytoplankton) are also important processes.

Threats: Many threats and stressors affect this subgroup. Shoreline modifications are assumed to have a direct impact on eelgrass, but changes due to nutrient enrichment are less clear. In other areas where eelgrass is found, there is a fairly strong inverse relationship between coastal watershed development and eelgrass integrity. However, because of the upwelling of nutrient rich oceanic water in the Puget Sound and the high tidal range, natural levels of nutrients in this area are of a greater magnitude than the influx from adjacent, developed lands. Eelgrass in the Puget Sound has evolved in a nutrient-rich environment, so deriving correlations between eelgrass trends and human stressors is difficult. There is little baseline data on which to base loss estimates (Mumford 2007). However, Thom and Hallum (1991) estimated a 30% and 15% loss of eelgrass area in Bellingham Bay and the Snohomish River delta, respectively. At the same time, they noted that eelgrass cover may have increased five-fold in Padilla Bay, while anecdotal evidence suggests eelgrass may have decreased in distribution in selected areas of the south Puget Sound. Aquaculture can displace or degrade eelgrass beds. *Z. japonica*, a nonnative species, can grow in shellfish beds. *Z. japonica* is one of the few expanding eelgrass species in the world; but it generally does not grow at the same depth as *Z. marina*. In Willapa Bay, shellfish operators are spraying *Z. japonica*—this may have secondary impacts on *Z. marina* populations, but it is difficult to know the degree of herbicide dispersal. Dredging of harbors can directly remove eelgrass beds and stir up sediment that shades out nearby plants. Dams on rivers may have unquantified impacts (positive or negative) on eelgrass integrity by changing sedimentation dynamics. Eelgrass doesn't do well when buried, but it does thrive within a particulare regime of fine-sediment. *Labyrinthula* (a naturally occurring slime mold) is a vector for eelgrass wasting disease, which causes a decline in photosynthetic capacity.

Classification Comments: This subgroup contains all aquatic bed vegetation communities dominated by *Zostera marina*.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification wetland and/or riparian associations that are associated with this subgroup:

AQUATIC VEGETATION

M184 Temperate Pacific Seagrass Intertidal Vascular Vegetation Macrogroup		
G373 Temperate Pacific Seagrass Group [Proposed]		
North Pacific Eelgrass Bed	Global/ State Rank	NatureServe/ WANHP Code
Zostera marina Pacific Coast Vegetation	GNR/SNR	CWWA000423

Other Wetland Subgroups in the Temperate Pacific Seagrass Group [Proposed] (G373):

- None

Relationship to Other Widely Used Wetland Classifications:

Cowardin System	Cowardin Class	HGM Class	HGM Subclass	Kunze 1994
?	?	?	?	n/a

Related Ecological Systems (Rocchio & Crawford, 2015a):

- North Pacific Maritime Eelgrass Bed

References: Barbour and Major 1988, Boggs 2002, Den Hartog 2003, Dethier 1990, Faber-Langendoen et al. 2015, Johnson and O'Neill 2001, Holland and Keil 1995, Mumford 2007, NatureServe Explorer 2007, Rocchio and Crawford 2015, Thom and Hallum 1991, Viereck et al. 1992, Washington DNR 2005

AQUATIC VEGETATION

North Pacific Freshwater Aquatic Vegetation

Concept: Rooted or floating aquatic plants confined to lakes, ponds, and slow-moving portions of rivers and streams. These aquatic beds are found throughout western Washington, from the lowlands to the subalpine, in water too deep for emergent vegetation.

Conservation Status: Vulnerable (S3). These communities remain relatively abundant on the landscape and may have even increased in some urban areas due to increased runoff. However, many occurrences are degraded due to development, agriculture, and logging. This rank was originally assigned to the Temperate Pacific Freshwater Aquatic Bed Ecological System, which is synonymous with this subgroup (Rocchio & Crawford, 2015b).

Distribution: These communities occur throughout western Washington where impounded water occurs, from the lowlands to subalpine.

Environment: These plant communities span large elevation ranges, from below 1000 feet in the Columbia Basin to over 7000 feet near the Cascade Crest. They are found in eutrophic ponds, sloughs, lake fringes, oxbows, or calm water of Rosgen C or E channels, in up to 2 m of water that may fluctuate or dry seasonally (Christy, 2004; Kovalchik & Clausnitzer, 2004). Water is too deep for emergent vegetation. In large bodies of water, they are usually restricted to the littoral region where penetration of light is the limiting factor for growth. Soils can be diverse, ranging from soft anoxic muck to peat to firm sand, but typically present qualities that result from long periods of anaerobic conditions (Kunze, 1994a).

Vegetation: Vegetation occurs as two general types of communities: floating (planmergent) and submerged communities. A third but less common type are peatland pools found in bogs and fens. Species found in floating (planmergent) communities include: *Azolla* spp., *Brasenia schreberi*, *Menyanthes trifoliata*, *Lemna* spp., *Nuphar lutea* ssp. *polysepala*, *Polygonum amphibium*, *Potamogeton* spp., *Ranunculus aquatilis*, *Callitriche* spp., *Schoenoplectus terminalis*, *Sparganium angustifolium*, *S. eurycarpum*, and *Wolffia* spp. *Nuphar lutea ssp. polysepala* communities are very abundant. Submerged vegetation can consist of *Myriophyllum* spp., *Ceratophyllum* spp., *Fontinalis* spp., *Elodea* spp., *Isoetes* spp., and/or *Utricularia* spp.

Ecological Processes: Development and distribution of these aquatic communities is determined primarily by water depth/fluctuation and shoreline gradeint. Relatively flat or gently sloping shorelines support a much larger marsh system than a steeply sloping shoreline. Water level fluctuations support the development of different marsh zones (floating, submergent, emergent, etc.), which vary according to the degree of inundation. Aquatic vegetation is able to tolerate long periods of or permanent anoxic conditions (Cronk & Fennessy, 2001). Other important factors are wave action, water temperature, substrate, and water chemistry (Pierce & Jensen, 2002; Kovalchik & Clausnitzer, 2004). These communities are generally intolerant of wave action (Pierce & Jensen, 2002), though *Isoetes* spp. may require waves to promote dispersal and reproduction.

Threats: There are no data sources that provide reliable estimates of loss. In fact, some stressors may have changed hydrology in favor of this subgroup by increasing inundation of depressions from increased runoff, thereby increasing open water areas. Some loss may occur due to road construction, especially in the lowlands. High elevation examples have likely not been affected to any significant degree. Observations indicate that grazing, roads, logging, and nonnative species continue to impact many occurrences. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roads or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland communities may reestablish to reflect new hydrology. Excess nutrient inputs could lead to the establishment of nonnative species and/or dominance of native increasing species. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. This may have led to a decrease in herbaceous wetlands (including aquatic habitat) in some portions of the landscape.

Classification Comments: This subgroup is geographically distinct from the Intermountain & Montane West Freshwater Aquatic Vegetation subgroup, which is restricted to eastern Washington.

USNVC Associated Types: The following table shows the U.S. National Vegetation Classification wetland and/or riparian associations that are associated with this subgroup:

M109 Western North American Freshwater Aquatic Vegetation Macrogroup			
	G544 Western North American Temperate Freshwater Aquatic Bed Group		
	North Pacific Freshwater Aquatic Vegetation Subgroup	Global/ State Rank	NatureServe / WANHP Code
Associations	*Azolla* (*filiculoides*, *mexicana*) Herbaceous Vegetation	G4/S4	CEGL003017
	Callitriche (*heterophylla*, *palustris*) Herbaceous Vegetation (Proposed Name change)	G4/S2	CEGL003301
	Brasenia schreberi Western Herbaceous Vegetation	G4?/S3S4	CEGL005200
	Elodea canadensis Herbaceous Vegetation	G5/S4?	CEGL003303

	Callitriche (*heterophylla*, *palustris*) Herbaceous Vegetation (Proposed Name change)	G4/S2	CEGL003301
	Nuphar lutea ssp. *polysepala* Herbaceous Vegetation	G5/S4S5	CEGL002001
	Ceratophyllum demersum Western Herbaceous Vegetation	G5/S4S5	CEGL004017
	Potamogeton (*foliosus*, *gramineus*) - (*Stuckenia filiformis*) Herbaceous Vegetation	GNR/SNR	CWWA000418
	Elodea canadensis Herbaceous Vegetation	G5/S4?	CEGL003303
	Potamogeton natans Herbaceous Vegetation	G5?/S5	CEGL002925
	Fontinalis (*antipyretica* var. *antipyretica*, *antipyretica* var. *oregonensis*) Nonvascular Vegetation	G4G5/S4	CEGL003304
	Isoetes echinospora - (*Lobelia dortmanna*) Herbaceous Vegetation	GNR/SNR	CWWA000425
	Lemna minor Herbaceous Vegetation	G5/S5	CEGL003305
	Menyanthes trifoliata Herbaceous Vegetation	G5/S4?	CEGL003410
	Myriophyllum hippuroides Herbaceous Vegetation [Provisional]	G3/S2?	CEGL003331
	Myriophyllum sibiricum Herbaceous Vegetation	GUQ/SNR	CEGL002000
	Nuphar lutea ssp. *polysepala* Herbaceous Vegetation	G5/S4S5	CEGL002001
	Polygonum amphibium Permanently Flooded Herbaceous Vegetation [Placeholder]	G5/S3?	CEGL002002
	Potamogeton natans Herbaceous Vegetation	G5?/S5	CEGL002925
	Ranunculus aquatilis Herbaceous Vegetation	G5/S4	CEGL003307
	Sagittaria latifolia Herbaceous Vegetation	G2/S1	CEGL003321
	Schoenoplectus subterminalis Herbaceous Vegetation [Provisional]	G3/S2?	CEGL003309
	Sparganium angustifolium Herbaceous Vegetation	G4/S3S4	CEGL001990
	Sparganium eurycarpum Herbaceous Vegetation	G4/S2S3	CEGL003323
	Utricularia macrorhiza Herbaceous Vegetation [Provisional]	G5/S4	CEGL003310
	Wolffia (*borealis*, *columbiana*) Herbaceous Vegetation [Provisional]	G4/S1?	CEGL003311

Other Wetland Subgroups in the Western North American Temperate Freshwater Aquatic Bed Group (G544):

- Intermountain & Montane West Freshwater Aquatic Vegetation

Relationship to Other Widely Used Wetland Classifications:

<table>
<tr><th>Cowardin System</th><th>Cowardin Class</th><th>HGM Class</th><th>HGM Subclass</th><th>Kunze 1994</th></tr>
<tr><td rowspan="2">Lacustrine</td><td>Aquatic Bed</td><td rowspan="2">Lacustrine-fringe</td><td rowspan="2">n/a</td><td rowspan="3">Low Elevation Mineratrophic</td></tr>
<tr><td>Emergent</td></tr>
<tr><td rowspan="3">Palustrine</td><td rowspan="3">Aquatic Bed</td><td rowspan="2">Depressional</td><td>Closed</td></tr>
<tr><td>Outflow</td><td>Overflow Plain</td></tr>
<tr><td>Riverine</td><td>Impounded</td><td>Surge Plain</td></tr>
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<table>
<tr><td rowspan="11"></td><td rowspan="11">Emergent</td><td rowspan="5">Depressional</td><td rowspan="2">Closed</td><td></td></tr>
<tr><td rowspan="2">Overflow Plain</td></tr>
<tr><td rowspan="3">Outflow</td></tr>
<tr><td>Low Elevation Mineratrophic</td></tr>
<tr><td rowspan="2">Surge Plain</td></tr>
<tr><td rowspan="2">Estuarine</td><td rowspan="2">Tidal fresh water</td></tr>
<tr><td rowspan="2">Overflow Plain</td></tr>
<tr><td rowspan="2">Lacustrine-fringe</td><td rowspan="2">n/a</td></tr>
<tr><td>Low Elevation Mineratrophic</td></tr>
<tr><td rowspan="3">Riverine</td><td rowspan="2">Impounded</td><td>Overflow Plain</td></tr>
<tr><td rowspan="2">Surge Plain</td></tr>
<tr><td>Riverine</td><td>Aquatic Bed</td><td>Flow-through</td></tr>
</table>

Related Ecological Systems (Rocchio & Crawford, 2015a):

- Temperate Pacific Freshwater Aquatic Bed

References: Christy 2004, Crawford 2003, Crowe et al. 2004, Jankovsky-Jones 2001, Kagan et al. 2004, Kovalchik and Clausnitzer 2004, Kunze 1994, MacKenzie and Moran 2004, Murray 2000, NatureServe Explorer 2007, Pierce and Jensen 2002, Rocchio 2006Rocchio and Crawford 2015